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(54) Throw-away type end mill

(57) First and second tips (4A) and (4B) are disposed on the outer periphery of the forward end of an end mill body (1) in the following manner. The tips (4A) and (4B) are displaced from each other in the peripheral direction of the end mill body (1). The rotation loci of edges of the first and second tips (4A) and (4B) around the axis (O) of the end mill body (1) are overlapped with each other. The edge of the first tip (4A) protrudes slightly farther toward the forward end of the end mill than the edge of the second tip (4B). Further, third tips (4C) ... are disposed adjacent to the base end of the second tip (4B) in such a manner that no gap is formed between the rotation locus of the edge of the third tip (4C) located most adjacent to the forward end of the end mill body and the rotation locus of the rear end of the second tip (4B). As a consequence, the second tip (4B) and the third tips (4C) ... can be spirally formed in the rearward rotating direction of the end mill as they go toward the base end of the end mill. The respective tips (4) ... are formed of only one type of tips of the same shape and dimensions.

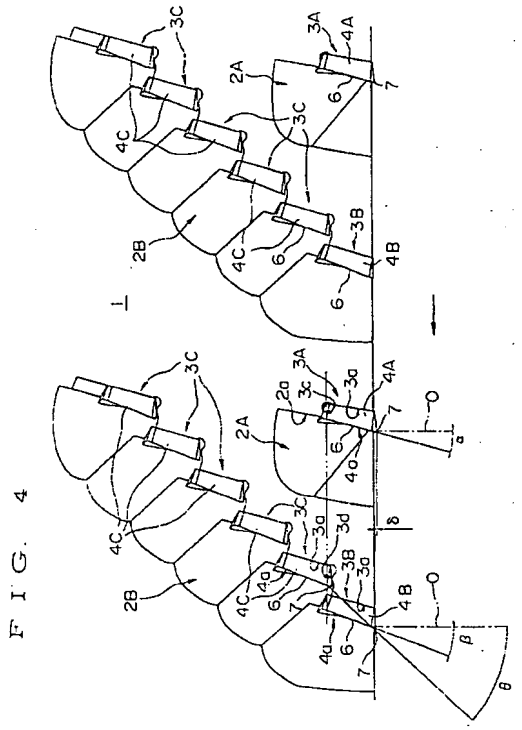

FIG. 4

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Description

The present invention relates to a throw-away type end mill used for performing a grooving or fluting operation on various types of workpieces.

As a throw-away end mill of this type, the end mill disclosed in Japanese Utility Model Publication No. 6-7855 is known by way of example. The end mill disclosed in this publication is constructed as follows. A plurality of tip mounting seats are spirally formed on the outer periphery of a generally cylindrical end mill body. Quadrilateral tabular throw-away tips (hereinafter referred to as "the tips") whose each face forming the quadrilateral shape is used as an outer peripheral relief face are detachably mounted on the respective tip mounting seats in such a manner the tips are directed toward the outer periphery of the end mill. Edges formed on the tips constitute the outer peripheral edges of the end mill in such a way that no gap is formed between the rotation loci of the edges formed on the tips around the axis of the end mill body.

On the other hand, a quadrilateral tabular tip formed in a shape different from the tips having the above-described outer peripheral edges is attached to the outer periphery of the forward end of the end mill body in such a manner that the face of the tip forming the quadrilateral shape is directed toward the forward end of the end mill. One of the edges formed on side ridges of the face forming the quadrilateral shape is used as an end cutting edge of the end mill. A forward-end and outer-peripheral edge is further provided with the tip, as well as the end cutting edge, in such a way that the forward-end and outer-peripheral edge extends from the end cutting edge and is directed toward the outer periphery of the forward end of the end mill body. No gap is formed between the rotation locus of the outer peripheral edges around the axis O and the rotation locus of the rear end of the forward-end and outer-peripheral edge so that the forward-end and outer-peripheral edge can constitute the forward end portion of the outer peripheral edges.

However, the throw-away type end mill constructed as described above presents the following problems. The tip forming the end cutting edge differs in shape from the tips forming the outer peripheral edges, which inevitably making the maintenance of tips in one end mill body complicated and troublesome. In particular, the tip attached to the forward end of the end mill body constitutes not only the end cutting edge, but also the forward-end and outer-peripheral edge which singly forms the forward end portion of the outer peripheral edges. Accordingly, this type of tip becomes worn very quickly. In addition to this disadvantage, since this tip is formed in a shape different from the other tips constituting the outer peripheral edges, the two types of tips are not interchangeable. This entails that an extra tip of the former type be kept in hand in advance in order to speedily cope with the aforementioned early wear, with the result that the maintenance of tips becomes further complicated and troublesome.

Accordingly, in view of the above-described background, an object of the present invention is to provide a throw-away type end mill in which the maintenance of tips can be simplified, and the wear of the forward-end and outer-peripheral edge of the tip which forms the end cutting edge can be inhibited, thereby achieving the longer life of the tip.

In order to achieve the above object, in a particularly preferred embodiment the present invention provides a throw-away type end mill comprising a generally cylindrical end mill body having a plurality of tip mounting seats formed on the outer periphery of the end mill body, and quadrilateral tabular throw-away tips of the same shape and dimensions detachably mounted on the mounting seats, respectively, in such a manner that a face forming the quadrilateral shape, serving as a rake surface, is directed in the rotating direction of the end mill and that a cutting edge formed on a side ridge of the rake face is positioned adjacent to the outer periphery of the end mill, wherein the throw-away type tips include at least a pair of throw-away type tips, each pair having first and second tips, disposed at the forward end of the end mill body, and at least one third throw-away type tip disposed adjacent to the base end of the second tip, the first and second tips being displaced from each other in the peripheral direction of the end mill body, wherein the rotation loci of the edges of the first and second tips around the axis of the end mill body are overlapped with each other, and the edge of the first tip is located to protrude slightly farther toward the forward end of the end mill than the edge of the second tip, the third tip being arranged in such a manner that no gap is formed between the rotation locus of the edge of the third tip and the rotation locus of the rear end of the edge of the second tip so that the second and third tips are spirally formed toward the rear rotating direction of the end mill as they go toward the base end of the end mill.

In the throw-away type end mill constructed as described above, the first tip constituting the end cutting edge is the same shape and dimensions as the second and third tips constituting the outer peripheral edges. That is, since all the tips attached to the end mill body are of only one type, the maintenance of the tips can be remarkably simplified. Additionally, the edge of the first tip serving as the forward-end and outer-peripheral edge is located in relation to the edge of the second tip in such a manner that the rotation loci of the edges of the first and second tips around the axis can be overlapped with each other. With this arrangement, a load acting upon the edge of the first tip can be decreased, thereby inhibiting the wear of the first tip.

The present invention is further illustrated, by way of examples and with reference to the accompagnated drawings, wherein :

Fig. 1 is a side view illustrating one embodiment of the present invention.

Fig. 2 is a front view of the embodiment shown in

Fig. 1, as viewed from the forward end thereof.

Fig. 3 is a plan view of the embodiment shown in Fig. 1, as viewed from the arrow X of Fig. 1.

Fig. 4 is an exploded side view of the embodiment shown in Fig. 1.

Fig. 5 is a side view illustrating another embodiment of the present invention.

Fig. 6 is a front view of the embodiment shown in Fig. 5, as viewed from the forward end thereof.

Fig. 7 is a plan view of the embodiment shown in Fig. 5, as viewed from the arrow Y of Fig. 5.

Fig. 8 is an exploded side view of the embodiment shown in Fig. 5.

Fig. 9 is a side view illustrating still another embodiment of the present invention.

Fig. 10 is a front view of the embodiment shown in Fig. 9, as viewed from the forward end thereof.

Fig. 11 is an exploded side view of the embodiment shown in Fig. 9.

An embodiment of the present invention will now be described with reference to Figs. 1-4.

In this embodiment, a generally cylindrical end mill body generally denoted by 1 is formed of a steel material, or the like. Four chip pockets 2 ... are formed at equal intervals circumferentially on the outer periphery of the forward end of the end mill body 1. Among these chip pockets 2 ..., one pair of chip pockets 2A, 2A oppositely facing each other across the axis O of the end mill body 1 are formed only at the forward end of the periphery of the end mill body 1. On the other hand, a pair of chip pockets 2B, 2B are spirally formed, extending in a twisting manner in the rearward rotating direction (indicated by the arrow in the figures) of the end mill around the axis O as they go from forward end to the base end on the outer periphery of the body 1.

First tip mounting seats 3A, 3A are respectively formed on the walls 2a of the pair of chip pockets 2A, 2A facing in the rotating direction of the end mill. On the other hand, second tip mounting seats 3B, 3B are respectively formed at the extreme forward ends of the wall surfaces of the chip pockets 2B, 2B facing in the rotating direction of the end mill. Five third tip mounting seats 3C ... are further formed farther toward the base end of the end mill than the second tip mounting seats 3B. First, second and third tips 4A, 4B and 4C are detachably fixed to the first, second and third tip mounting seats 3A, 3B and 3C, respectively, by means of clamp screws 5. Accordingly, in this embodiment, two pairs of tips, each pair having first and second tips 4A and 4B, are provided for one end mill body 1.

In this embodiment, all the first, second and third tips 4A, 4B and 4C are each formed of a hard material, such as a cemented carbide or the like, in the shape of a tabular parallelogram of the substantially same shape and dimensions. The tips 4 are of the type of positive tips constructed as described below. Major cutting edges 6, 6 are formed on the long side ridges of one face 4a forming the parallelogram, while lateral faces formed between the respective major cutting edges 6, 6 and the other face of the parallelogram each have an angle of relief. Further, minor cutting edges 7, 7 are formed on the short side ridges of the above-described face 4a in such a manner that they extend from the major cutting edges 6, 6, respectively. One of the minor cutting edges 7, 7 of the first tip 4A is used as an end cutting edge of the end mill.

Among the tip mounting seats 3A, 3B and 3C having the aforementioned tips 4A, 4B and 4C mounted thereon, the first tip mounting seat 3A is defined by a bottom surface 3a directing in the rotating direction of the end mill, a wall surface 3b raised from the bottom surface 3a and directing toward the outer periphery of the end mill, and a wall surface 3c also raised from the bottom surface 3a and directing toward the forward end of the end mill. The first tip mounting seat 3A constructed as described above is formed in a recessed shape in one step backward from the wall surface 2a of the chip pocket 2 in the rearward rotating direction of the end mill.

The above-described first tip 4A is mounted on the first mounting seat 3A according to the following process. The major face 4a forming the parallelogram, serving as a rake face, is directed in the rotating direction of the end mill, while the other face forming the parallelogram, serving as a seating face, is intimately seated on the bottom surface 3a. One of the major cutting edges 6 and the associated minor cutting edges 7 are positioned adjacent to the outer periphery and the forward end of the end mill, respectively. The lateral faces continuing from the other major and minor cutting edges 6 and 7 are brought into contact with the wall surfaces 3b and 3c, respectively. With this construction, the major cutting edge 6 located toward the outer periphery of the end mill has a positive axial rake angle α, as shown in Fig. 4. The axial rake angle α provided for the cutting edge 6 of the first tip 4A is desirably set to be in a range of from 5° to 15°. In this embodiment, the axial rake angle α is set to be 14°.

Among the above-described tip mounting seats 3A, 3B and 3C, the second tip mounting seats 3B, 3B are each defined by a bottom surface 3a facing in the rotating direction of the end mill and a wall surface 3b facing toward the outer periphery of the end mill. The third tip mounting seats 3C are each defined by a wall surface 3d facing toward the base end of the end mill in addition to the aforementioned bottom surface 3a and the wall surface 3b. This wall surface 3d is disposed to extend from the base end of the bottom surface 3a of the adjoining mounting seat 3B or 3C located farther toward the forward end of the end mill. Accordingly, the second tip mounting seats 3B and 3C are spirally disposed in the form of steps on the wall surface of the chip pocket 2B facing in the rotating direction of the end mill. The helical angle θ of the spiral formed by the second and third tip mounting seats 3B and 3C ... is desirably set to be in a range of from 40° to 56°. In this embodiment, the helical angle θ is set to be 43°.

The second tip 4B is mounted on the second tip mounting seat 3B according to the following process. The abovementioned face 4a serving as the rake face is directed in the rotating direction of the end mill, while the other face serving as the seating face is brought into intimate contact with the bottom surface 3a. Further, one of the major cutting edges 6 is positioned on the outer periphery of the end mill, and the lateral face extending from the other cutting edge 6 is brought into intimate contact with the wall surface 3b. Moreover, the third tips 3C ... are mounted on the third mounting seats 3C respectively, in a manner similar to the second tip 3B. The rake face 4a is directed in the rotating direction of the end mill, while the other face is brought into intimate contact with the bottom surface 3a. Further, one of the cutting edges 6 is positioned on the outer periphery of the end mill, while the lateral face extending from the other edge 6 is brought into intimate contact with the wall surface 3b. Then, the lateral face extending from the minor cutting edge 7 adjacent to the forward end of the end mill is brought into intimate contact with the wall surface 3d.

The cutting edge 6 of the second tip 4B located on the outer periphery of the end mill, as well as the cutting edge 6 of the first tip 4A, has a positive axial rake angle. In this embodiment, the axial rake angle β of the second tip 4B is set greater to the side of the positive angle than the axial rake angle α of the first tip 4A. The axial rake angle β of the cutting edge 6 of the second tip 4B is desirably set to be in a range of from 10° to 30°. In this embodiment, the angle β is set to be 20°. The cutting edges 6 of the respective third tips 4C .. also have the same axial rake angle β equal to the angle provided for the cutting edge 6 of the second tip 4B.

Since the second and third tip mounting seats 3B and 3C ... are disposed in the form of steps in this embodiment, the axial rake angle β never becomes greater than the helical angle θ of the second and third tip mounting seats 3B and 3C ...

The rear end of the cutting edge 6 of the second tip 4B is located in the same axial position as the rear end of the edge 6 of the first tip 4A along the axis O. Because of this arrangement, the rotation locus of the edge 6 of the first tip 4A is overlapped with the locus of the edge 6 of the second tip 4B.

In this embodiment, however, the axial rake angle β of the cutting edge 6 of the second tip 4B is set greater than the angle α of the edge 6 of the first tip 4A. With this arrangement, the forward end of the cutting edge 6 of the first tip 4A protrudes slightly farther toward the forward end of the end mill than the forward end of the edge 6 of the second tip 4B.

Thus, in this embodiment, the rear ends of the edges 6 of the first and second tips 4A and 4B are placed in the same axial position along the axis O, while the axial rake angles α and β of the respective edges 6 are set different from each other. As a consequence, the cutting edge 6 of the first tip 4A protrudes slightly farther toward the forward end of the end mill than the edge 6 of the second tip 4B. This positional relationship between the edges 6 of the first and second tips 4A and 4B may be achieved by the following modification. That is, the axial rake angles α and β may be set equal to each other, while the rear end of the first tip 4A is displaced from that of the second tip 4B along the axis O.

The protrusion amount δ of the cutting edge 6 of the first tip 4A in relation to the edge 6 of the second tip 4B is desirably set to be in a range of from 0.1 mm to 3.0 mm. In this embodiment, the protrusion amount δ is set to be 0.4 mm.

The third tips 4C ... are each located in such a manner that the forward end of the cutting edge 6 thereof is positioned slightly farther toward the forward end of the end mill in the direction of the axis O than the rear end of the edge 6 of the adjoining second tip 4B or the adjoining third tip 4C toward the forward end of the end mill. With this construction, a train of the cutting edges 6... is formed on the outer periphery of the end mill body 1 in such a way that no gap is formed between the rotation loci of the edges 6 ... around the axis O from the forward end adjacent to the edges 6, 6 of the first and second tips 4A and 4B to the base end of the end mill. The peripheral edges of the throw-away type end mill of this embodiment are thus formed.

In the throw-away type end mill constructed as described above, the first, second and third tips 4A, 4B and 4C ... are formed in the same shape and same dimensions and are thus interchangeable. Accordingly, when replacements of tips 4 are required due to abrasion, chipping, etc., it is essential only that one type of spare tips 4 be kept on hand, thereby coping with speedy replacements of any of the tips 4A, 4B and 4C. This makes it possible to extremely simplify the maintenance of the tips 4 in the end mill body 1, thereby reducing the labor required for the maintenance of tips and providing increased working efficiency.

There sometimes may be cases in which the third tip 4C adjacent to the base end of the end mill body 1 is not actually used for cutting, for example, in case in which the depth of cut to be formed by the throw-away type end mill is small. In such a case, one of the tips 4A - 4C which have become worn or chipped may be replaced with the third tip 4C which is not used for cutting. With this replacement, the wear of the tips 4 can be promptly handled without the necessity of having to keep spare tips 4 on hand, thereby further increasing working efficiency.

Moreover, only a pair of trains of the cutting edges 6 ... of the continuous five third tips 4C ... are disposed adjacent to the base end on the outer periphery of the end mill body 1. In contrast, two pairs of tips, each pair having first and second tips 4A and 4B, that is, two pairs of the edges 6, 6, are disposed adjacent to the forward end on the outer periphery of the end mill body 1 in such a manner that the rotation locus of the edges 6 of the first tips 4A around the axis O is overlapped with the

locus of the edges 6 of the second tips 4B. With this construction, it is possible to decrease a load acting upon the individual edges 6 of the first and second tips 4A and 4B during a cutting operation. This inhibits the frequencies of occurrences of wear and chipping, thereby achieving the longer life of the tips.

In particular, in the first tip 4A whose minor cutting edge 7 extending from the major cutting edge 6 is used as the end cutting edge of the end mill, it is likely that the wear of the overall tip 4A will be hastened due to abrasion of the cutting edge 7. Under these conditions, if the load acting upon the cutting edge 6 of the first tip 4A during a cutting operation is equal to the load upon the edges 6 of the third chips 4C ...., which has been suffered by the foregoing conventional end mill, the first tip 4A becomes seriously worn out, which may result in the necessity of very frequent replacements of the first tips 4A. Further, the above conventional type of the end mill is employed for cutting by rotating the generally cylindrical end mill body 1 around the axis O after the base end of the end mill body 1 is attached to the spindle of a machine tool, such as a machining center or the like. Consequently, it is very likely that a deflection will occur to the forward end of the end mill body 1 which is located farthest away from the spindle. This deflection may easily increase the cutting load acting upon the cutting edge 6 of the first tip 4A located at the extreme forward end of the body 1, thereby further accelerating the wear of the tip 4A.

In contrast to the conventional type of end mill, the throw-away type end mill of this embodiment is constructed as described above. Namely, the rotation locus of the cutting edge 6 of the first tip 4A is overlapped with the locus of the edge 6 of the second tip 4B, thereby inhibiting the abrasion of the edge 6 of the first tip 4A. This makes it possible to ensure the uniformity of the degree of wear among the first, second and third tips 4A, 4B and 4C, thereby preventing very frequent replacements of the tips.

Due to the synergistic effect of the aforementioned advantage and the foregoing simplified maintenance for tips, the overall easy maintenance of tools can also be enhanced, thereby further improving the working efficiency.

Further, the tip mounting seat 3A is independently formed in a position in which it is circumferentially displaced from the second tip mounting seat 3B which forms steps with the third chip mounting seats 3C ... located at the base end. Because of this construction, the first tip mounting seat 3A can be defined by the bottom surface 3a facing in the rotating direction of the end mill, the wall surface 3b facing toward the outer periphery of the end mill, and the wall surface 3c facing toward the forward end of the end mill. The first tip 4A can be accurately and securely mounted on the mounting seat 3A along the axis O by bringing the lateral face of the first tip 4A into contact with the wall surface 3c. Along with this secure fixation of the first tip 4A, the minor cutting edge 7 of the first tip 4A protruding to the forward end of the end mill so as to be used as the end cutting edge can be accurately located along the axis O. Accordingly, by use of the throw-away type end mill constructed as described above, the bottom face of a workpiece can be finished with high precision in a grooving or fluting operation.

On the other hand, since the second tip mounting seat 3B is defined by only the bottom surface 3a and the wall surface 3b facing toward the outer periphery of the end mill, the second tip 4B is not so securely located along the axis O as the first tip 4A. However, since the minor cutting edge 7 of the second tip 4B is located in a more receding position toward the base end than the edge 7 of the first tip 4A, it is not involved in the actual cutting operation. As a consequence, even if the second tip 4B is mounted on the mounting seat 3B along the axis O with a small amount of errors, the precision of the machined bottom face of a workpiece cannot be impaired.

On the contrary, in this embodiment, the second tip mounting seat 3B and the third tip mounting seats 3C ... are not each provided with the wall surface 3c facing toward the forward end of the end mill but provided with the bottom surface 3a and the wall surface 3d which are spirally disposed in the form of steps in the rearward rotating direction of the end mill. The base end of the above-described face 4a forming the parallelogram, which is used as the rake face of each of the tips 4B and 4C ... mounted on the respective mounting seats 3B and 3C can thus be freed into the chip pocket 2B. According to this embodiment constructed as described above, a large volume of comparatively-broad chips produced by the cutting edges 6 ... of the second and third tips 4B and 4C ... can be speedily discharged into the tip pockets 2 from the respective rake faces, and can be smoothly exhausted to the exterior.

Also, in this embodiment, all the tips 4 ... attached to the end mill body 1 each have a positive axial rake angle. In particular, in the first and second tips 4A and 4B attached to the forward end of the end mill body 1, the axial rake angle β of the cutting edge 6 of the second tip 4B is set greater than the axial rake angle α of the edge 6 of the first tip 4A. With this arrangement, the tips 4 of the same shape and same dimensions whose cutting edges 6 also have the same length are used as the first and second tips 4A and 4B. Moreover, on one hand, the rear ends of the cutting edges 6 of the first and second tips 4A and 4B are located in the same axial position along the axis O. On the other hand, the forward end of the cutting edge 6 of the first tip 4A protrudes slightly farther toward the forward end of the end mill than that of the edge 6 of the second tip 4B. With this construction, the associated minor cutting edge 7 can be used as an end cutting edge.

The rear ends of the edges 6 of the first and second tips 4A and 4B are located in the same axial positions along the axis O, as described above, which would oth-

erwise cause the generation of steps on a work surface during a grooving or fluting operation. By virtue of this advantage, the work wall surface can be machined with high precision. Additionally, the bottom work surface can also be machined with high precision by use of only the minor cutting edge 7 of the first tip 4A as the end cutting edge. Given the aforementioned advantages, according to this embodiment, it is thus possible to form the overall machined surface with high precision in a grooving or a fluting operation.

In this embodiment, the protrusion amount δ of the cutting edge 6 of the first tip 4A in relation to the edge 6 of the second tip 4B, that is, the protrusion amount of the minor cutting edge 7 of the first tip 4A provided for a cutting operation in relation to the edge 7 of the second tip 4B which is not used for cutting, is set to be 0.4 mm. If this protrusion amount 6 is excessively great, the amount of overlapping of the edges 6 of the first and second tips 4A and 4B becomes relatively small. This may increase the degree of the wear of the first tip 4A, in particular, the forward end thereof, which may further lead to inconsistencies in the degree of the wear among the tips. On the other hand, if the protrusion amount δ is excessively small, the minor cutting edge 7 of the second tip 4B may interfere with the bottom work surface which should be singly cut by the edge 7 of the first tip 4A, which may cause an impairment of the precision of the machined bottom surface of a workpiece.

Because of the reasons given above, the protrusion amount δ is desirably set to be in a range of from 0.1 mm to 3.0 mm as described above.

Also, in this embodiment, the axial rake angle α of the major cutting edge 6 of the first tip 4A is set to be 14°, while the axial rake angle β of the edge 6 of the second tip 4B is set to be 20°. The latter angle β is set greater than the former angle α so that tne above-described protrusion amount δ can be obtained. If this axial rake angle α is too great, an amount of relief between the bottom work surface and the lateral face of the first tip 4A facing toward the forward end of the end mill, that is, the lateral face serving as a relief face provided with the minor cutting edge 7 used as the end cutting edge may become insufficient.

Moreover, in this embodiment, the greater the axial rake angle α of the cutting edge 6 of the first tip 4A, the greater the axial rake angle β of the second and third tips 4B and 4C ... accordingly. In other words, the axial rake angles of the edges 6 of all the tips 4 ... attached to the end mill body 1 become greater, which shortens the overall length of the edges 6 ... along the axis O. This entails that a larger number of tips 4 be attached to the end mill body 1. Or, if the cutting edge 6 is linearly formed, the distance from the edge 6 to the axis O varies from the forward end to the rear end of the edge 6, which may further cause deformation of the work wall surface.

Conversely, the smaller the axial rake angle β, the smaller the axial rake angle α accordingly. An excessively small angle α brings about an increase in the cutting resistance acting upon the major cutting edge 6 and the minor cutting edge 7 of the first tip 4A, which is used as the end cutting edge, which may disadvantageously promote the abrasion of the first tip 4A and increase the frequency of occurrence of chipping. This may result in inconsistencies in the degree of the wear among the tips 4 ...

In order to avoid the above-described possible problems, the axial rake angle α of the cutting edge 6 of the first tip 4A is desirably set to be in a range of from 5° to 15°, while the axial rake angle β of the edge 6 of the second tip 4B is desirably set to be in a range of from 10° to 30°.

Still further, the following type of tabular positive tips are used as the first, second and third tips 4A, 4B and 4C in this embodiment. As described above, the major cutting edges 6, 6 are formed on the long side ridges of one face (rake face) 4a forming the parallelogram, and lateral faces (relief faces) formed between the cutting edges 6, 6 and the other face (seating face) forming the parallelogram each have an angle of relief. The minor cutting edges 7, 7 are formed at the short side ridges of the rake face 4a in such a manner that they extend from the major cutting edges 6, 6, respectively. More specifically, the tip disclosed in Japanese Patent Laid-Open No. 5-305914 is desirably used as the first, second and third tips 4A, 4B and 4C ... in this embodiment.

This tip has been invented by the present inventors. A nose portion is formed at a corner of a polygonal tabular tip body. A cutting edge is formed to extend from the nose portion and located on at least one of two intersecting ridges formed by a pair of adjacent lateral faces of the tip body across the nose portion and by one face of the tip body extending from the nose portion. The aforementioned face forms slant faces tilting toward the other face of the tip body as they go farther away from the nose portion. In accordance with the slant faces, the above-described two intersecting ridges also slant toward the other face of the tip body as they go farther away from the nose portion. The ridges formed by the respective slant faces and the respective lateral faces constitute brakes. As discussed above, at least one cutting edge slants toward the other face of the tip body as it goes farther away from the nose portion. With this construction, the axial rake angle and the radial rake angle can be set greater regardless of the angle of the bottom surface of the tip mounting seat.

The aforementioned tip constructed as described above is employed as the above-described tips 4 for use in the throw-away type end mill. Accordingly, it is possible to ensure a sufficient thickness of the tip mounting seats 3 ... of the end mill body 1 in the rearward rotating direction of the end mill, while the cutting edges 6 ... of the first, second and third tips 4A, 4B and 4C ... have the foregoing suitable axial rake angles α and β. This improves the rigidity of the end mill body 1 so as to prevent the occurrence of the deflection of the end mill body 1. With this advantage, according to this embodiment,

it is further possible to effectively inhibit the wear of the tips, in particular, the wear of the first and second tips 4A and 4B located adjacent to the forward end of the end mill which are inevitably subjected to an increased load due to the possible deflection of the end mill body 1. The life of the tips can thus be further prolonged.

Figs. 5 - 8 illustrate another embodiment of the present invention. The same elements as those described in the embodiment shown in Figs. 1 - 4 are designated by like reference numerals.

In this embodiment, a pair of chip pockets 2A and 2B are formed at the forward end of the outer periphery of the end mill body 1 in such a manner that they are located substantially opposedly facing each other with respect to the axis O. First and second tips 4A and 4B are mounted on tip mounting seats 3A and 3B formed at the forward ends of the chip pockets 2A and 2B, respectively.

More specifically, this embodiment is constructed as follows. A pair of first and second tips 4A and 4B are disposed at the forward end of the end mill body 1. The rotation locus of the cutting edges 6, 6 of the first tip 4A around the axis O is overlapped with the locus of the edges 6, 6 of the second tip 4B. Also, the edge 6 of the first tip 4A protrudes slightly farther toward the forward end of the end mill than the edge 6 of the second tip 4B. Further, three third tips 4C ... are disposed adjacent to the base end of the second tip 4B in such a manner that no gap is formed between the rotation locus of the edge 6 of the tip 4C located most adjacent to the forward end of the end mill body and the rotation locus of the rear end of the edge 6 of the second tip 4B. Because of this arrangement, the third tips 3C ... can be spirally formed in the rearward rotating direction of the end mill as they go toward the base end of the end mill.

Further, chip pockets 2C are formed on the outer periphery of the end mill body 1 so that they can be circumferentially located between the chip pockets 2A and 2B. Three fourth tip mounting seats 3D are each provided on the wall surface of the chip pocket 2C directing in the rotating direction of the end mill in such a way that they are spirally disposed in the form of steps toward the rearward rotating direction of the end mill as they go toward the base end of the end mill. Three fourth tips 4D are mounted on the mounting seats 3D, respectively. Accordingly, the fourth tips 4D ... are displaced from the first, second and third tips 4A, 4B and 4C in the peripheral direction of the end mill body 1.

The fourth tips 4D are each generally formed in the shape of a tabular parallelogram of the same shape and dimensions as the first, second and third tips 4A, 4B and 4C. The fourth tips 4D are also disposed in relation to the third tips 4C and the first tip 4A in the following manner. The rotation locus of the cutting edges 6 ... of the respective fourth tips 4D around the axis O is overlapped with the locus of the edges 6 ... of the respective third tips 4C. Also, no gap is formed-between the rotation locus of the edge 6 of the fourth tip 4D most adjacent to the forward end of the end mill body and the locus of the rear end of the edge 6 of the first tip 4A. In this embodiment, the axial rake angle β of the edge 6 of each of the fourth tips 4D is set to be equal to be the axial rake angle β of the edges 6 of the second and third tips 4B and 4C.

The throw-away type end mill of this embodiment is constructed in a manner similar to the end mill of the previous embodiment. That is, all the tips 4A - 4D attached to the end mill body 1 are formed in the same shape and dimensions. Also, the rotation loci of the edges 6, 6 of the first and second tips 4A and 4B located at the forward end of the end mill body are overlapped with each other. Moreover, the edge 6 of the first tip 4A protrudes slightly farther toward the forward end of the end mill than the edge 6 of the second tip 4B. Accordingly, advantages similar to those obtained in the previous embodiment can be realized.

In addition to the above-described construction, this embodiment is provided with the fourth tips 4D ... so that the rotation locus of the edges 6 of the fourth tips 4D can be overlapped with the locus of the edges 6 ... of the third tips 4C ... With this arrangement, the cutting load acting upon the individual edges 6 of the third and fourth tips 4C ... and 4D ... can be decreased. This can inhibit the degree of the wear and the occurrence of chipping more reliably, thereby achieving the much longer life of the tips.

Additionally, in this embodiment, the first and second tips 4A and 4B are displaced from each other in the peripheral direction of the end mill body 1. Then, the fourth tips 4D ... are further displaced from the first, second and third tips 4A, 4B and 4C in the peripheral direction. With this arrangement, the peripheral distance between the edges 6, 6 of the first and second tips 4A and 4B differs from the peripheral distance between the edges 6, 6 of the third and fourth tips 4C and 4D. This differentiates the cycle in which a cutting load acts upon the forward end of the end mill body from the cycle in which a load acts upon the portion adjacent to the base end of the end mill during a cutting operation.

With this construction, a cutting load acting upon the first and second tips 4A and 4B and a load upon the third and fourth tips 4C ... and 4D ... offset each other. This prevents a cutting load at a fixed cycle from acting upon the overall end mill body 1 during a cutting operation, which would otherwise cause chattering in the end mill body 1 due to the cyclic load. As a consequence, the precision of the machined surface can further be improved, and the wear of the tips, in particular, the wear of the first and second tips 4A and 4B located at the forward end of the end mill body, can be inhibited more reliably.

In the foregoing two embodiments, all the tips 4A - 4D are formed in the shape of a tabular parallelogram of the same shape and same dimensions. However, all the tips attached to the end mill body 1 may be formed, for example, in a generally tabular square shape, as in-

dicated by 14 shown in Figs. 9 - 11. The same elements of an embodiment shown in Figs. 9 - 11 as those shown in Figs. 1 - 4 are designated by like reference numerals.

The tip 14 is formed of a hard material, for example, cemented carbide or the like, and of the type of a positive tip constructed as described below. Major cutting edges 6 are formed on the respective four side ridges of one surface 14a, serving as a rake face, forming the generally square shape. At the same time, a minor cutting edge 17 is formed between the adjoining edges 16, 16. Lateral faces formed between the rake face 14a and the other face forming the square shape each has an angle of relief.

The tips 14 constructed as described above are detachably fixed to the mounting seats, respectively, by means of clamp screws 5. More specifically, the first and second tips 14A and 14B are respectively mounted on the first and second tip mounting seats 3A and 3B provided at the forward end of the end mill body 1. The third tips 14C are mounted on the third mounting seats 3C... spirally formed in the shape of steps adjacent to the base end of the second tip mounting seat 3B. In this embodiment, two pairs of tips, each pair having first and second tips 14A and 14B, are disposed at the forward end of the end mill body 1, while two third tips 14C are arranged adjacent to the base end of the second tip 14B.

Further, the first and second tips 14A and 14B positioned at the forward end of the end mill body 1 are located in the following manner. The edges 16, 16 of the first and second tips 14A and 14B positioned adjacent to the outer periphery of the end mill have positive axial rake angles α and β, respectively. On the other hand, the minor edges 17, 17 of the first and second tips 14A and 14B extending from the edges 16, 16 positioned adjacent to the forward end of the end mill have negative radial rake angles γ and ϕ, respectively. Also, the edges 16, 16 of the respective tips 14A and 14B positioned on the outer periphery of the end mill are located in such a manner that the distance from the forward end of the edges 16, 16 to the axis O is equal to the distance from the rear end thereof to the axis O.

The throw-away type end mill is constructed in a manner similar to the previous embodiments. That is, the first, second and third tips 14A, 14B and 14C are formed in the same shape and dimensions. The rotation loci of the edges 16, 16 of the first and second tips 14A and 14B around the axis O are overlapped with each other, and the edge 16 of the first tip 14A protrudes slightly farther toward the forward end of the end mill than the edge 16 of the second tip 14B. With this arrangement, advantages similar to those obtained by the previous two embodiments can be realized.

Additionally, since four major edges 16 ... and associated minor edges 17 can be formed on one tip 14 in this embodiment, this tip can be utilized more efficiently twice as much as the above-described tips 4 formed in the shape of the tabular parallelogram. This can further prolong the life of the tips so as to improve the cost efficiency.

In addition to the above-described construction, the following arrangement is made to this embodiment. The major edge 16 of the first tip 14A positioned toward the outer periphery of the end mill has a positive axial rake angle α, while the minor edge 17 positioned toward the forward end of the end mill has a negative radial rake angle γ. The distance from the forward end of the edge 16 to the axis O is equal to the distance from the rear end thereof to the axis O. Because of this arrangement, it is possible to provide an angle of relief for the edge 16 positioned on the inner periphery of the minor edge 17, serving as the end cutting edge, during a cutting operation, which prevents the edge 16 located on the inner periphery of the forward end of the end mill from interfering with the work bottom surface during a cutting operation. Accordingly, this embodiment is advantageous because it can take precautions against a possible deterioration in the precision of the machined bottom surface caused by the interference of the edge 16 and also it can avoid waste and make the best use of the four major edges 16 ... formed on the tip 14.

The same advantages also apply to the second tip 14B whose minor edge 17 positioned toward the forward end of the end mill is provided with a negative radial rake angle ϕ. Even if the protrusion amount δ of the edge 16 of the first tip 14A is small, the edge 16 of the second tip 14B located on the inner periphery of the forward end of the end mill

Claims

1. A throw-away type end mill comprising a generally cylindrical end mill body (1)) having a plurality of tip mounting seats (3A, 3B, 3C, 3D) formed on the outer periphery of said end mill body (1), and quadrilateral tabular throw-away tips (4A, 4B, 4C, 4D), of the same shape and dimensions detachably mounted on said mounting seats (3A, 3B, 3C, 3D), respectively, in such a manner that a face forming the quadrilateral shape, serving as a rake surface, is directed in the rotating direction of said end mill and that a cutting edge (6,7) formed on a side ridge of said rake face is positioned adjacent to the outer periphery of said end mill.

2. A throw-away type end mill according to claim 1, wherein said throw-away type tips (4A, 4B, 4C, 4D) include at least a pair of throw-away type tips (4A, 4B), each pair having first (4A) and second tips (4B) disposed at the forward end of said end mill body (1) said first (4A) and second tips (4B) being displaced from each other in the peripheral direction of said end mill body (1).

3. A throw-away type end mill according to one of claims 1 and 2, wherein the rotation loci of the edges

of said first and second tips (4A, 4B) around the axis (O) of said end mill body (1) are overlapped with each other, and the edge of said first tip (4A) is located to protrude slightly farther toward the forward end of said end mill than the edge of said second tip (4B).

4. A throw-away type end mill according to any one of claims 1 - 3, wherein said throw-away type tips (4A, 4B, 4C, 4D) include at least one third throw-away type tip (4C) disposed adjacent to the base end of said second tip (4B).

5. A throw-away type end mill according to any one of claims 1 - 4, wherein said third tip (4C) being arranged in such a manner that no gap is formed between the rotation locus of the edge of said third tip (4C) and the rotation locus of the rear end of the edge of said second tip (4B) so that said second and third tips (4B, 4C) are spirally formed toward the rear rotating direction of said end mill as they go toward the base end of said mill.

6. A throw-away type end mill according to any one of claims 1 - 5, wherein a protrusion amount of the edge of said first tip (4A) in relation to the edge of said second tip (4B) is set to be in a range of from 0.1 to 3.0 mm.

7. A throw-away type end mill according to any one of claims 1 - 6, wherein the edge of each of said tips (4A, 4B, 4C, 4D) has a positive axial rake anlge, (α, β, δ), and the axial rake angle (β) of the edge of said second tip (4B) is set greater than the angle (α) of the edge of said first tip (4A).

8. A throw-away type end mill according to claim 7, wherein the axial rake angle (α) of the edge of said first tip (4A) is set to be in a range of from 5° to 15°, while the axial rake angle (β) of the edge of second tip (4B) is set to be in a range of from 10° to 30°.

9. A throw-away type end mill according to any one of claims 1 - 8, wherein at least one fourth throw-away type tip (4D) is disposed on the outer periphery of said end mill body (1), displaced from said first, second and third tips (4A, 4B, 4C) in the peripheral direction of said end mill, in such a manner that the rotation locus of the edge of said fourth tip (4D) around the axis (0) is overlapped with the locus of the edge of said third tip (4C) and that no gap is formed between the rotation locus of the edge of said fourth tip (4D) and the rotation locus of the rear end of the edge of said first tip (4A).

FIG. 1

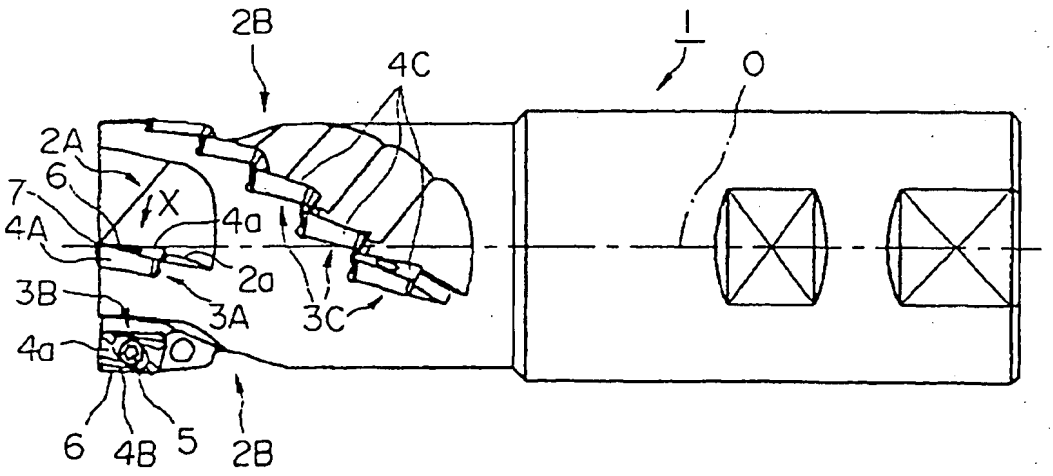


FIG. 2

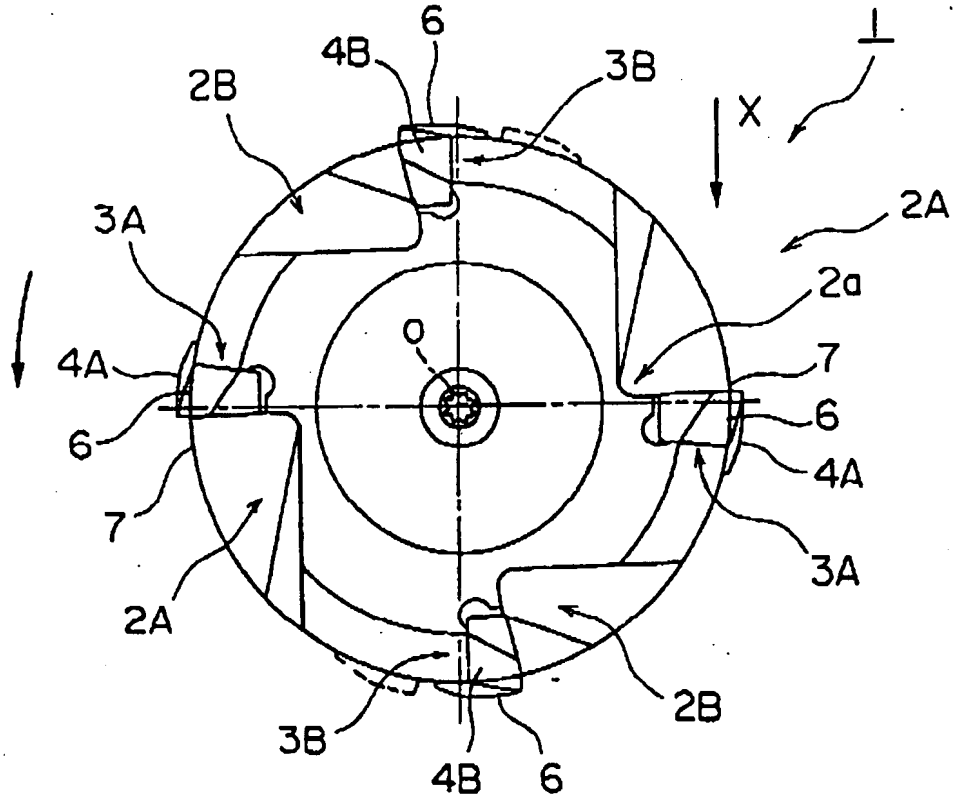


FIG. 3

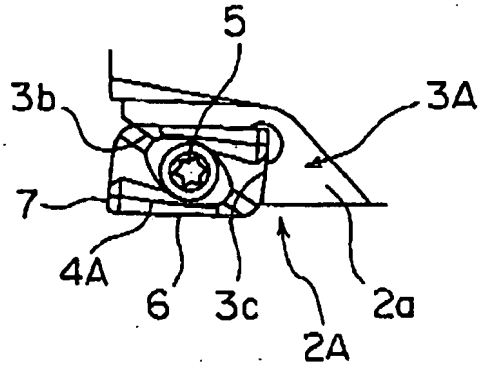


FIG. 4

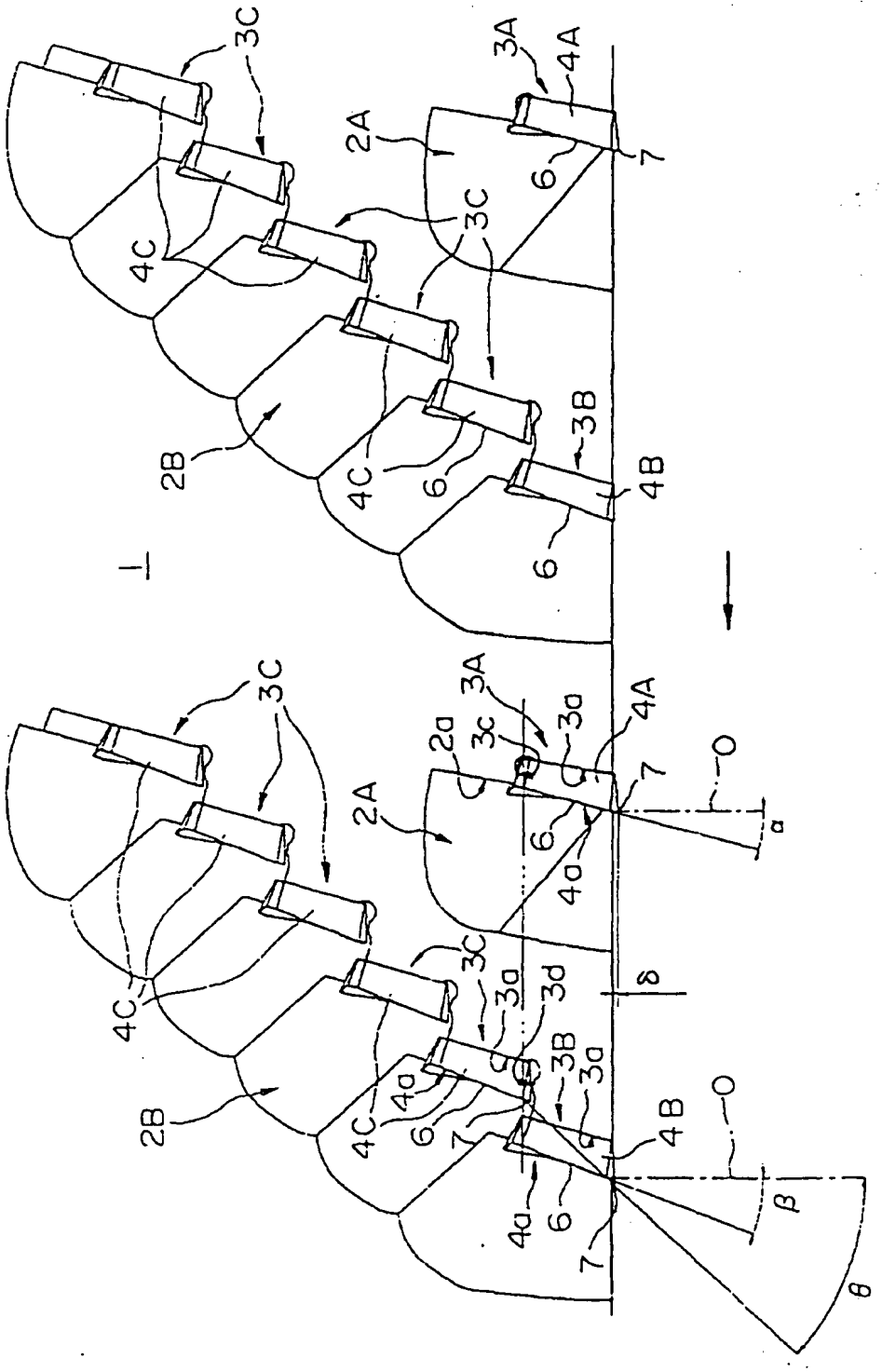


FIG. 5

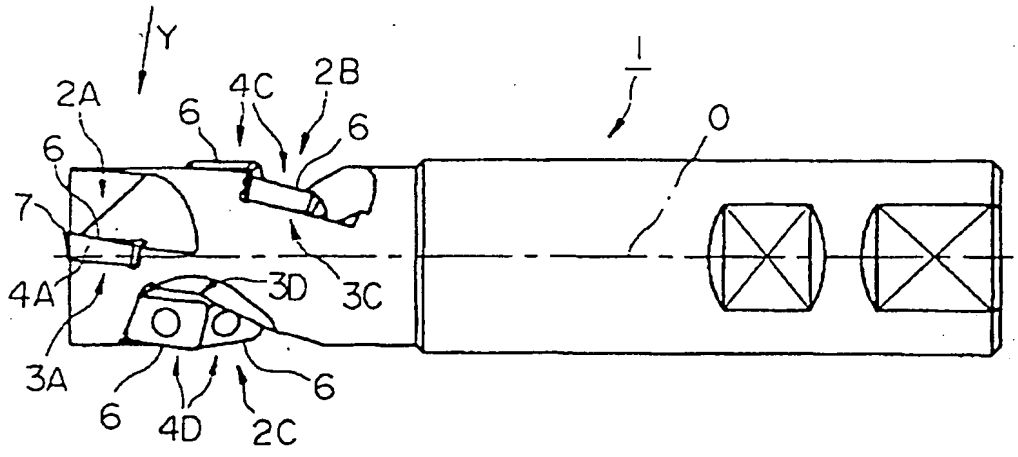


FIG. 6

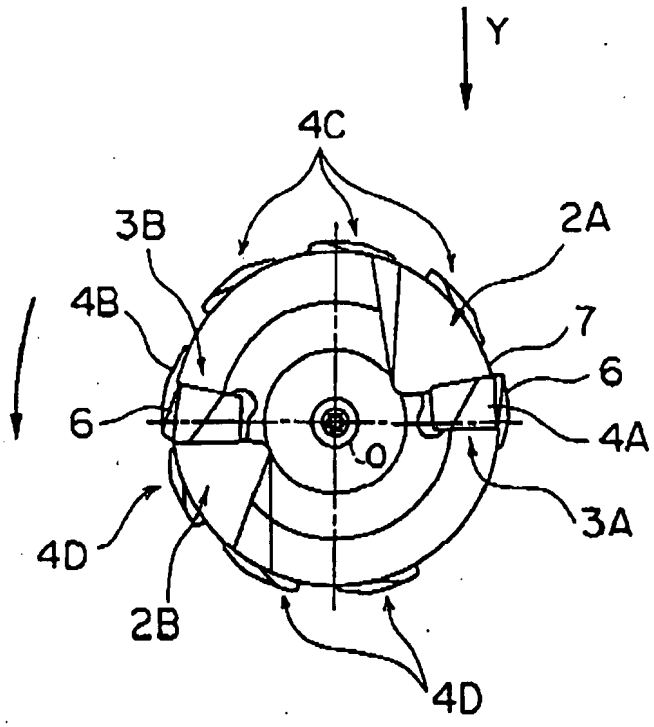
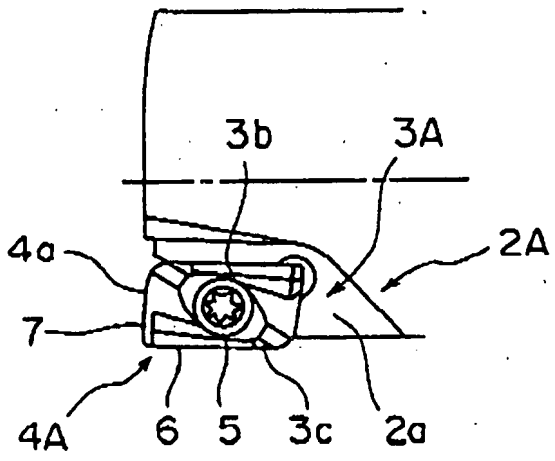


FIG. 7



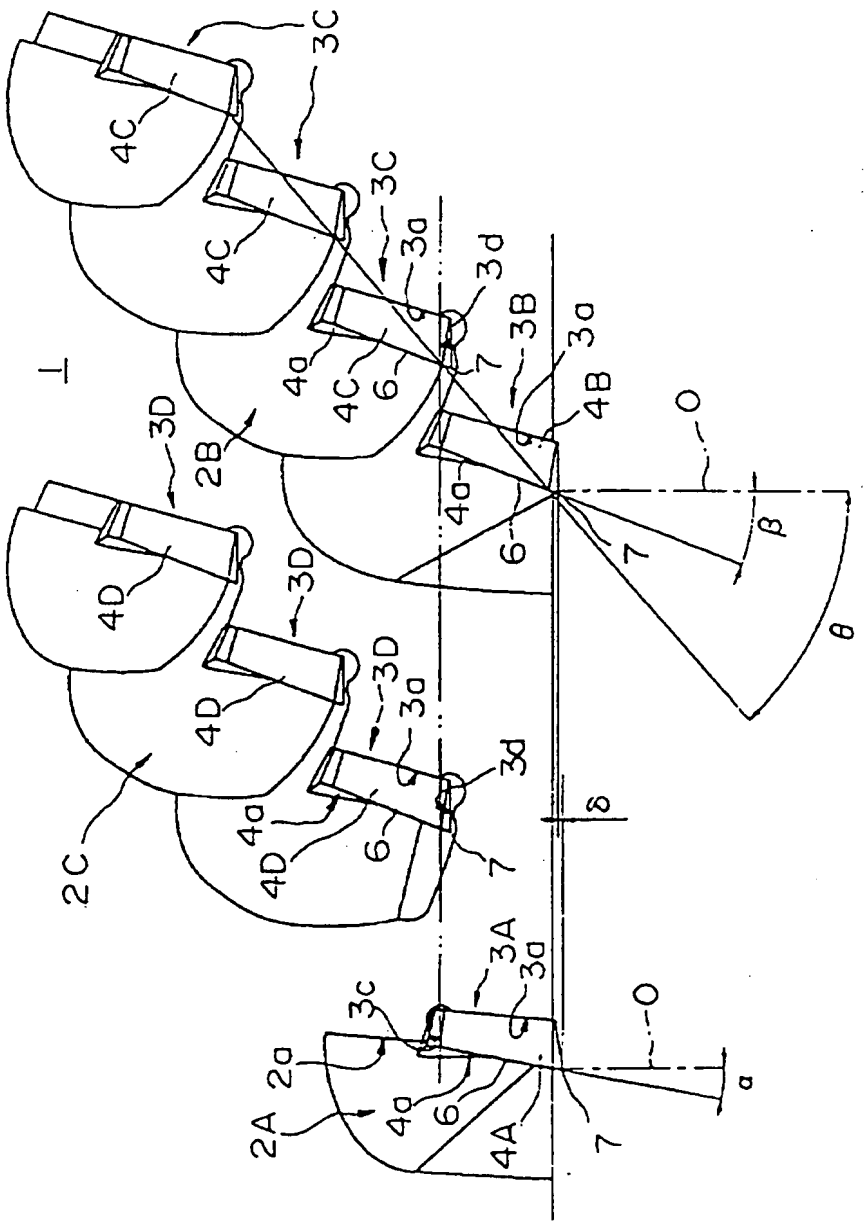
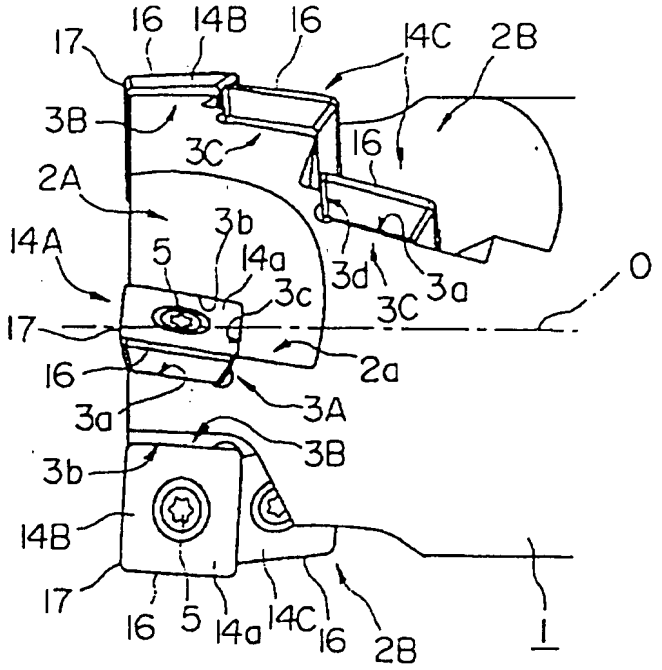


FIG. 8

FIG. 9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14B
16
14C
2B
17
3B
3C
16
2A
3b
14A
5
14a
3d
3a
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3c
3C
17
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3A
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3B
3b
14B
17
16
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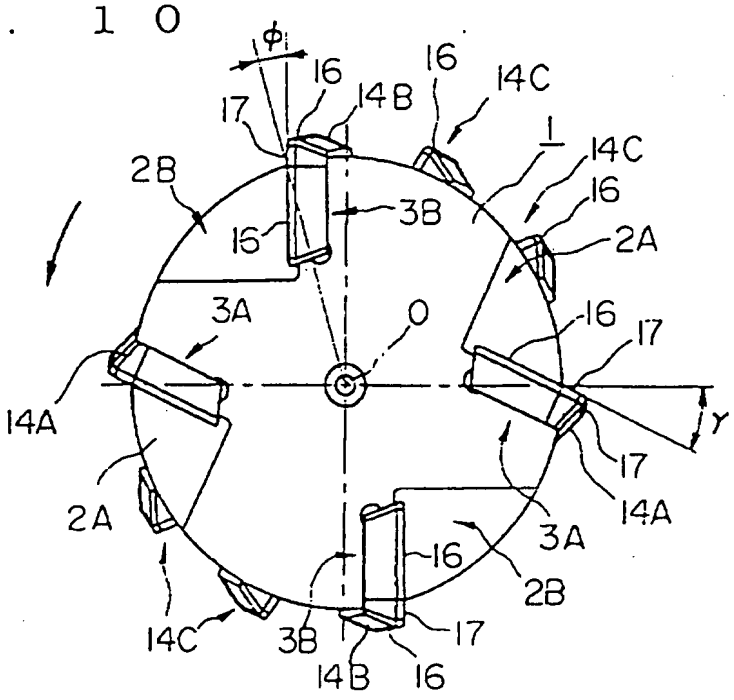
14a
14C
16
2B
I

FIG. 10


φ
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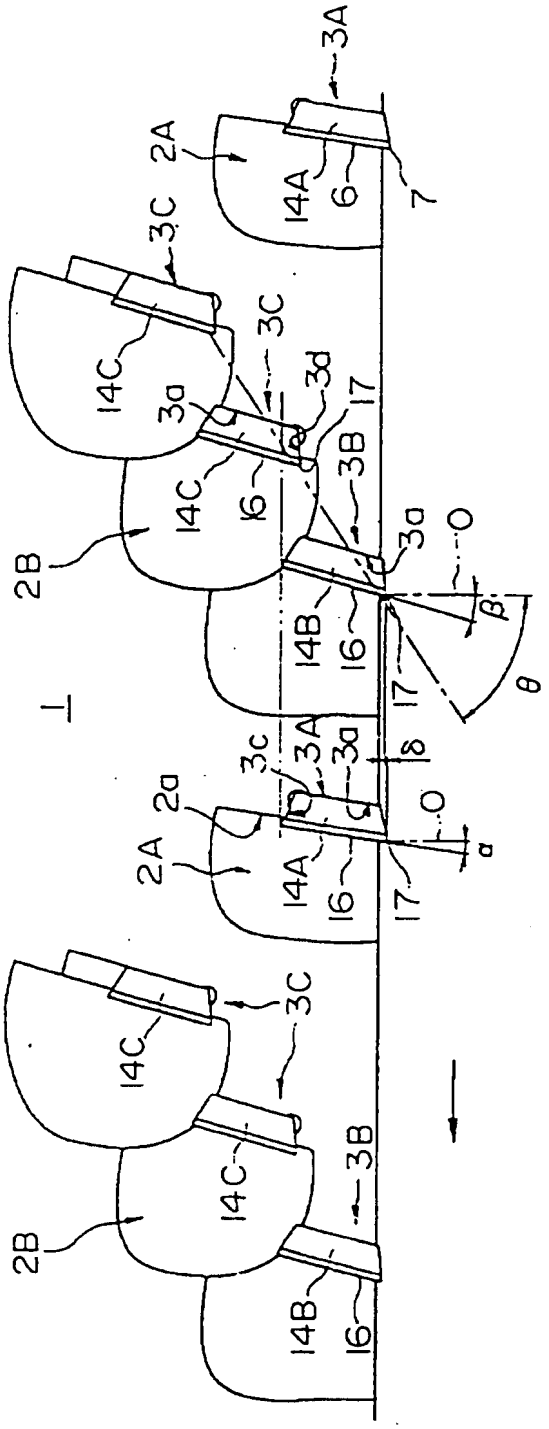
16


3A
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14A
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3C
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β
14B
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3c
3A
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17
α
3C
14C
3B
2B
14C
14B
16

FIG. 11

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 11 7449

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	DE-A-33 14 049 (MONTANWERKE) * page 9 - page 11; figures 1-6 *	1,2,4 6-9	B23C5/10
A	EP-A-0 278 389 (INGERSOLL) * column 4, line 31 - line 35; figures 1,3,13 *	2	
A	DE-A-38 12 150 (DOTANY)		
A	DE-A-37 27 968 (MITSUBISHI)		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B23C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31 January 1996	Bogaert, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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THROW-AWAY END MILL

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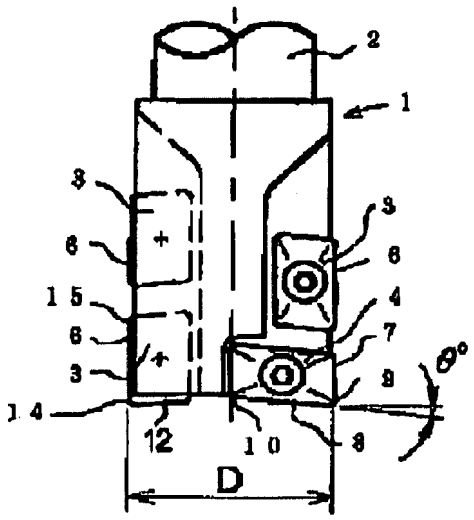
Publication date: 1998-11-04
Inventor: TAKAHASHI ISATO; SUGANO YOSHIOMI
Applicant: HITACHI TOOL ENG CO LTD
Classification:
- international: ***B23C5/10;*** **B23C5/10;** (IPC1-7): B23C5/10
- European: B23C5/10F
Application number: JP19970116349 19970418
Priority number(s): JP19970116349 19970418

Abstract of **JP10291115**

PROBLEM TO BE SOLVED: To provide an end mill which is applicable to various operations in a throw away end mill in which a first tip and a second tip are used as positive tips of a parallelogram, by improving the strength, rigidity of a tool body and obtaining a cutting tool shape provided with sharp cutting edge. SOLUTION: In a throw-away end mill in which a first tip 3 and a second tip 4 as positive tips of parallelogram are used, and the outer peripheral cutting edge is arranged about parallel to the axis, the first tip 3 is arranged at the tip end peripheral part so that the long side is an outer peripheral cutting edge 6 and the short side is a bottom cutting edge 12, and from the bottom face view, on the 180 deg. opposite side of the first tip 3, the second tip 4 is arranged symmetrically with respect to the first tip 3, and is reorientated 180 deg. from the first tip. The second tip 4 is structured so that the long side is a bottom cutting edge 8 and the short side is an outer peripheral cutting edge 7 and so that the height of cutting edge is lowered from the bottom edge-outer peripheral side at which the long side intersects the short side at an acute angle, toward the bottom-edge center shaft side at which the long side intersects the short side at an obtuse angle, that is, an inclined cutting edge can be obtained when viewed from the tip side face.



(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平10－291115

(43)公開日　平成10年(1998)11月４日

(51)Int.Cl.[6]	識別記号	ＦＩ	
Ｂ２３Ｃ　5/10		Ｂ２３Ｃ　5/10	Ｄ

審査請求　未請求　請求項の数２　ＦＤ　（全　４　頁）

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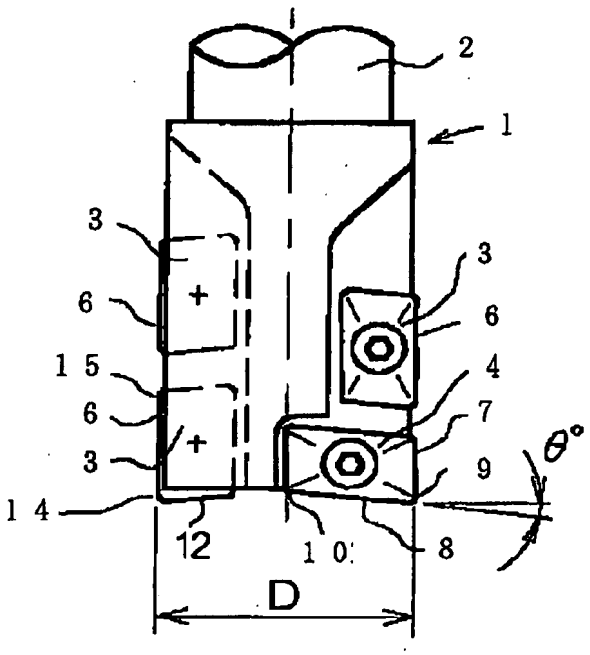
(54)【発明の名称】　スローアウェイエンドミル

(57)【要約】

【目的】　平行四辺形のポジチップである第１チップと第２チップを用いたスローアウェイエンドミルにおいて、工具本体の強度、剛性の向上を図り、シャープな切刃を備えた刃型とする事により、多様な作業に適用できるエンドミルを提供することを目的とする。

【構成】　平行四辺形のポジチップである第１チップと第２チップを用い、外周刃が軸線と略平行となる様なスローアウェイエンドミルにおいて、前記第１チップは長辺が外周刃、短辺が底刃となる様先端外周部に配置されており、そして底面視において第１チップと略１８０度の反対側には上記第１チップと線対称で勝手を逆にする第２チップがあり、前記第２チップは長辺が底刃、短辺が外周刃でかつ長辺が短辺と鋭角で交わる底刃外周側から長辺が短辺と鈍角で交わる底刃中心軸側に向けてチップ側面視で刃先高さが低くなる傾斜刃となる様に構成する。



【特許請求の範囲】
【請求項1】　平行四辺形のポジチップである第1チップと第2チップを用い、外周刃が軸線と略平行となる様なスローアウェイエンドミルにおいて、前記第1チップは長辺が外周刃、短辺が底刃となる様先端外周部に配置されており、そして底面視において第1チップと略180度の反対側には上記第1チップと線対称で勝手を逆にする第2チップがあり、前記第2チップは長辺が底刃、短辺が外周刃でかつ長辺が短辺と鋭角で交わる底刃外周側から長辺が短辺と鈍角で交わる底刃中心軸側に向けてチップ側面視で刃先高さが低くなる傾斜刃となっていることを特徴とするスローアウェイエンドミル。
【請求項2】　請求項1記載のスローアウェイエンドミルにおいて、前記第1チップ、第2チップの外周刃に続いて、複数の第1チップを軸方向にずらして配置させたことを特徴とするスローアウェイエンドミル。
【発明の詳細な説明】
【0001】
【産業上の利用分野】本願発明は、フライス工具として用いられるスローアウェイ式エンドミルで、特に3次元切削が可能な底刃付きエンドミルに関する。
【0002】
【従来の技術】スローアウェイエンドミルとしては、工具正面側の切刃である底刃がエンドミルの軸心まで延びており、その例として特開平8－323527号公報に記載の例がある。前記エンドミルは同一形状の平行四辺形チップを用いて、工具径中心までの底刃と長辺が外周刃となるようにして、かつそのチップを軸方向にずらして切刃長さを大きくした底刃付きのエンドミルである。また、底刃に関してはエンドミル先端に装着される2枚のチップのうち、一方のチップの長辺切刃を工具径中心まで延びる底刃、短辺切刃を外周刃とし、又他方のチップの短辺切刃を底刃、長辺切刃を外周刃としたことにより、一種類のチップによって工具径中心までの底刃と外周刃をまかなえるので、チップ管理上及び使用上も便利である。
【0003】
【発明が解決しようとする課題】しかしながら、前記エンドミルは、肩削りや溝削りにおいて短辺切刃を底刃とし、長辺切刃を外周刃とするチップの先端コーナ部が欠けやすい。これは同一形状チップを用いているので、先端部での切刃配置は図1のようになるためである。すなわち、外周刃は2枚刃であるため、それでなくても一番損傷を受けやすい先端コーナを含む外周刃の口部は1枚刃仕様となっているため送り量も2倍かかり、欠損が一段と生じやすくなっている。その為、先端コーナ部をまかなうチップは刃先強度アップの目的でチップ厚さを大きくしたりしているが、チップ一定、つまり刃先高さ一定のチップでは、工具径中心付近を切刃が通るようにチップ厚さ分、工具本体のチップ座を深く下げて加工する必要があり、工具本体の剛性低下よりビビリやすくなるなどの問題を生じていた。
【0004】
【課題を解決するための手段】従って、本願発明では平行四辺形のポジチップである第1チップと第2チップを用い、外周刃が軸線と略平行となる様なスローアウェイエンドミルにおいて、前記第1チップは長辺が外周刃、短辺が底刃となる様先端外周部に配置されており、そして底面視において第1チップと略180度の反対側には上記第1チップと線対称で勝手を逆にする第2チップがあり、前記第2チップは長辺が底刃、短辺が外周刃でかつ長辺が短辺と鋭角で交わる底刃外周側から長辺が短辺と鈍角で交わる底刃中心軸側に向けてチップ側面視で刃先高さが低くなる傾斜刃となっているスローアウェイエンドミルとしたものである。
【0005】
【作用】本願発明の特徴として第1に、工具径中心までの底刃を形成する第2チップは、長辺が外周刃を形成する第1チップの逆勝手であるので、切刃先端での切刃配置は図2のようになり、以下の特徴を有する。
（1）一番損傷を受けやすい先端コーナ部を含む外周刃の先端部を2枚刃仕様とすることができるので、先端1枚刃仕様のものと比べ安定した高能率切削ができる。
（2）底刃を使う突込み作業等では、平行四辺形ゆえ底刃すかし角θがあり切刃は外周側より徐々に当るので、求心性があり、安定切削できる。もちろん横に送れば底刃すかし角θが付いているのでビビリもなく底面を平らに加工することができる。
（3）工具径中心までの底刃を形成する第2チップは外周側から工具中心側に向けて刃先高さが低くなる傾斜刃となっているので、中心側の低い刃先高さに合せてチップ座を加工すればよく、よって一番過酷となる外周側での刃先高さを小さくすることなしに工具本体剛性の工向上を計ることができる。
【0006】第2に、請求項1の第1チップ、第2チップの外周刃に続いて、複数の第1チップを軸方向にずらして配置、つまり工具径中心までの底刃を形成する第2チップ1個と、長辺が外周刃を形成する複数の第1チップとからなるロング刃タイプのスローアウェイエンドミルとすることにより、刃長を長くし、より深切込み切削も可能となる。また、外周刃の配置は、軸方向にずらして配置し、第1チップの軸方向先端位置は、ねじれ角10°～30°の仮想線上に配置され、かつ、軸方向のずらし量X＝2～5mmである。
【0007】外周刃となる第1チップの配置は、10°未満では喰付き時の衝撃大きくビビリやすい。30°以上では、切屑排出溝であるチップポケットの加工分が多くなり工具本体剛性低下よりやはりビビリやすくなる。又、第1チップの軸方向のずらし量Xは工具先端に取付けられる第1チップ、第2チップの軸方向位置決め及び

保持に必要な最少肉厚であり、このずらし量Ｘが、横送り切削時のロング刃でのニックの役目をする。２ｍｍより小さいと上記位置決め、保持の強度面で好ましくなく、５ｍｍより大きくなると切刃分割のニック的意味合いのスキマというより、１枚刃仕様となってしまうので２～５ｍｍの範囲が良い。更に、第１チップにおいて、長辺が短辺と鋭角で交わる外周刃先端側から短辺と鈍角で交わる外周刃後端側に向けて、側面視で刃先高さが低くなる傾斜刃となっている。

【０００８】刃先高さ一定、つまりチップ厚さが一定のチップでは工具本体の軸方向すくい角（アキシャルレーキ）を付けるのにチップ座加工でそのすくい角分傾けて製作していたが、外周刃が傾斜刃になっているとその角度分は工具本体のチップ座を傾ける必要がないので、チップを受ける工具本体のバックメタルが大きくなり同じアキシャルレーキでも工具本体強度を向上することができる。逆に、従来と同じ傾きのチップ座にすると、傾斜刃の分アキシャルレーキは大きくとれるので、工具本体強度を落とすことなく切削性能に優れた工具とすることができる。

【０００９】

【実施例】図３～図６は本発明の一実施例を示す。図において、ストレートシャンク２を有する工具本体１の先端には平行四辺形のポジチップである第１チップ３と第２チップ４がチップポケット５を有するチップ座内に止めねじにより着脱可能に取付けられている。そしてこれら先端の第１チップ、第２チップの外周刃６、７に続いて軸方向のずらし量Ｘをへだててそれぞれ１個の第１チップがねじれ角α°の仮想線上で先端チップと同様に取付けられている。よって該エンドミルは、第１チップ３個と第２チップ１個からなるロング刃タイプの底刃付きエンドミルである。ここで第２チップ４は、第１チップ３と線対称つまり勝手を逆にする平行四辺形で、長辺が工具径中心までの底刃８、短辺が外周刃７を形成し、底刃外周側９から底刃中心軸側１０に向けて刃先高さが低くなる傾斜刃となっている。よって、工具本体のチップ座はチップ厚さの小さい底刃中心軸側１０の刃先高さに合せて加工されている。

【００１０】又、第１チップ３は長辺が外周刃１１、短辺が底刃１２を形成すると平行四辺形ポジチップであるが、実施例では好ましい形である長辺が短辺と鋭角で交わる外周刃先端側１３から短辺と鈍角で交わる外周刃後端側１４に向けて刃先高さが低くなる傾斜刃となっている。そして上記軸方向のずらし量Ｘの所は反対側の第１チップの外周刃４で切削する形となっている。尚、第１チップ、第２チップにおける傾斜刃の形は直線でも曲線でも、更にはこれらの組み合せでも良く、要は刃先高さ変化がある形なら良い。

【００１１】次に切削試験について説明する。外径Ｄ＝３２ｍｍ、第１チップ３は長辺の長さ１５．８７５ｍｍ、短辺の長さ９．５２５ｍｍ鋭角で交わる頂角が８５°の平行四辺形で、外周刃先端側での刃先高さ４．７６ｍｍ、外周刃後端側での刃先高さ４ｍｍの傾斜になっている。又、第２チップ４は第１チップに線対称の逆勝手で長辺の長さ１６．５ｍｍ、短辺の長さ９．５２５ｍｍ鋭角で交わる頂角は第１チップ同様８５°でよって、チップセット時の底刃すかし角θは５°である。又第１チップ３の軸方向ずらし量Ｘは３ｍｍで、ねじれ角α＝２０°の仮想線上に配置されている。そして、チップテスト時の刃先のアキシャルレーキは８°であるが、傾斜刃なので工具本体の座くり角度は４°である。

【００１２】本エンドミルを用いて、被削材Ｓ５０Ｃ（２２０ＨＢ）を切削速度１２０ｍ／ｍｉｎにて切削テストした。切削幅が刃径の半分１６ｍｍ、軸方向の切込み深さ２５ｍｍにもかかわらず、１刃当りの送り量０．２５ｍｍ／刃でも安定して切削することができた。

【００１３】

【発明の効果】本願発明のエンドミルを適用することにより、スローアウェイチップの最も損傷を受けやすい先端コーナ部を含む外周刃の先端部を２枚刃仕様とし、さらにチップに傾斜をさせることらより工具本体剛性の向上が計れ、安定した切削が可能となったた。また、突っ込み作業等でも底刃すかし角θにより、外周より徐々に当るので安定した切削ができた。

【図面の簡単な説明】

【図１】図１は、従来例における工具先端の切刃配置を説明する略図を示す。

【図２】図２は、本発明例における工具先端の切刃配置を説明する略図を示す。

【図３】図３は、本発明例の正面図を示す。

【図４】図４は、図３の右側面図を示す。

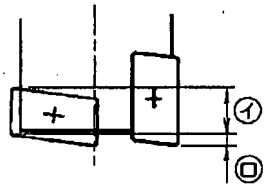
【図５】図５は、図３の左側面図を示す。

【図６】図６は、図３の底面図を示す。

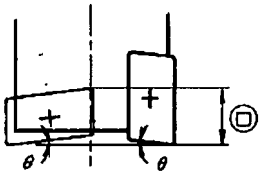
【符号の説明】

１　工具本体
２　ストレートシャンク
３　第１チップ
４　第２チップ
５　チップポケット
６　第１チップの外周刃
７　第２チップの外周刃
８　第２チップの底刃
９　第２チップの底刃外周側
１０　第２チップの底刃中心軸側
１１　第１チップの長辺（外周刃）
１２　第１チップの短辺（底刃）
１３　外周刃先端側
１４　外周刃後端側
Ｘ　ずらし量
α　ねじれ角

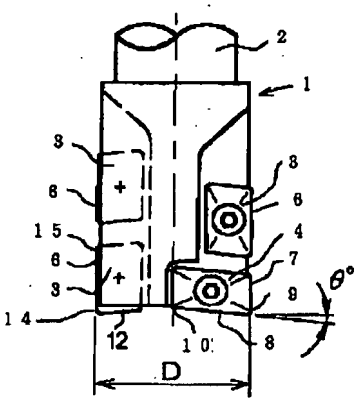
【図１】



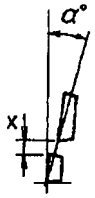
【図２】



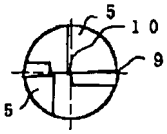
【図３】



【図４】



【図６】



【図５】